

# Quantitative Measurements of Ablation-Products Transport for Turbulence Model Validation

Completed Technology Project (2011 - 2015)



## Project Introduction

In recent years NASA has developed renewed interest in the study of ablation owing to the need to develop suitable thermal protection systems for spacecraft that undergo planetary entry. Ablation is a complex multi-physics process, and codes that predict it require a number of coupled submodels, each of which requires validation. For example, Reynolds-averaged Navier Stokes (RANS) and large-eddy simulation (LES) codes require models of the turbulent transport of ablation products under variable compressibility and pressure gradient conditions; however, suitable scalar-velocity data under relevant conditions are very rare. One means of obtaining such data is to transpire a gas, such as NO, into a turbulent boundary layer and to measure its dispersion with a technique such as planar laser-induced fluorescence (PLIF). Alternatively, a new technique has been developed at The University of Texas at Austin that uses PLIF of a low-temperature sublimating ablator (naphthalene) to enable visualization of the ablation products in a hypersonic turbulent boundary layer. However, for either the transpired gas or low-temperature ablation techniques to be useful, their fluorescence signals must first be studied over the wide range of pressures and temperatures that may be present in a given wind tunnel. Fluorescence models of NO and naphthalene vapor will be obtained by monitoring the fluorescence signals of these species in a pressure and temperature controlled test cell. The goal of this project is to conduct the fundamental spectroscopic measurements that are required to enable the acquisition of quantitative images of the transport of the ablation products of a re-entry vehicle model in a supersonic wind tunnel. The proposed work will mainly be conducted at research laboratories on the campus of the University of Texas at Austin under the supervision of Dr. Noel Clemens. This work will complement the NO PLIF work being conducted in the Mach 10 wind tunnel at NASA's Langley Research Center, since recent work has demonstrated problems with making the measurements quantitative. This proposal relates directly to sections 14.3.1 (Entry and Ascent TPS) and 9.1.1 (Rigid TPS) of NASA's Space Technology Roadmaps Technology Area Breakdown Structure.

## Anticipated Benefits

The goal of this project is to conduct the fundamental spectroscopic measurements that are required to enable the acquisition of quantitative images of the transport of the ablation products of a re-entry vehicle model in a supersonic wind tunnel.



Project Image Quantitative Measurements of Ablation-Products Transport for Turbulence Model Validation

## Table of Contents

Project Introduction	1
Anticipated Benefits	1
Organizational Responsibility	1
Primary U.S. Work Locations and Key Partners	2
Project Management	2
Technology Maturity (TRL)	2
Technology Areas	2
Images	3
Project Website:	3

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Responsible Program:

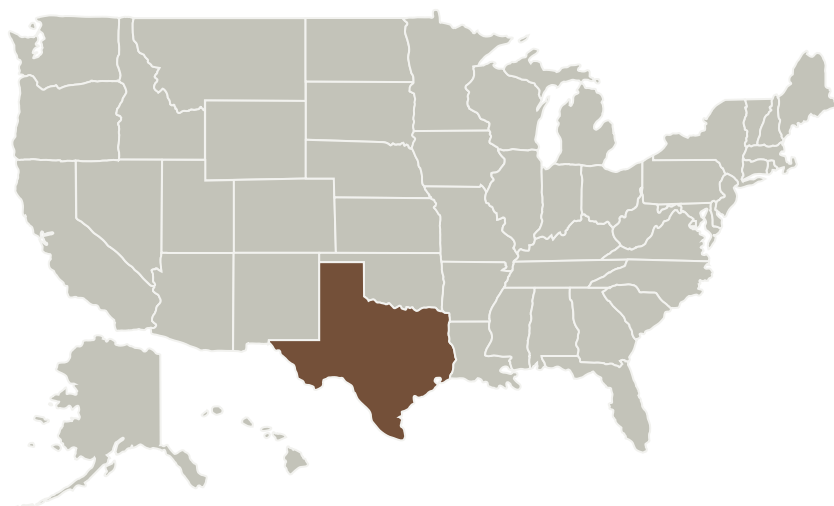
Space Technology Research Grants

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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Austin	Supporting Organization	Academia	Austin, Texas

## Primary U.S. Work Locations

Texas

## Project Management

### Program Director:

Claudia M Meyer

### Program Manager:

Hung D Nguyen

### Principal Investigator:

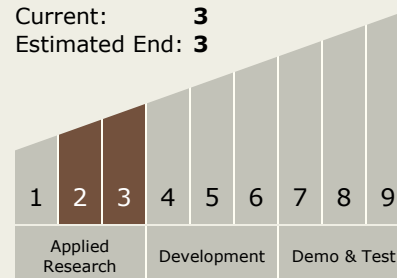
Noel Clemens

### Co-Investigator:

Christopher S Combs

## Technology Maturity (TRL)

Start: 2  
Current: 3  
Estimated End: 3



## Technology Areas

### Primary:

- TX09 Entry, Descent, and Landing
  - TX09.4 Vehicle Systems
    - TX09.4.5 Modeling and Simulation for EDL

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## Images



**4315-1363263423478.jpg**

Project Image Quantitative  
Measurements of Ablation-Products  
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Validation

(<https://techport.nasa.gov/image/1812>)

## Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>